

Benefits, consequences, and uncertainties of conventional (exercise) countermeasure approaches

This presentation will review the pros, cons, and uncertainties of using exercise countermeasures in hypothetical long duration exploration missions. The use of artificial gravity and exercise will be briefly discussed. One benefit to continued use of exercise is related to our extensive experience with spaceflight exercise hardware and programming. Exercise has been a part of each space mission dating back to the 1960's when simple isometric and bungee exercises were performed in the Gemini capsule. Over the next 50 years, exercise hardware improved cumulating in today's ISS suite of exercise equipment: CEVIS, T2 and ARED. Today's exercise equipment is the most robust ever to be flown in space and allows the variety and intensity of exercise that might reasonably be expected to maintain muscle mass and function, bone density and cardiovascular fitness.

A second benefit is related to the large body of research literature on exercise training. There is a considerable body of supporting research literature including >40,000 peer reviewed research articles on exercise training in humans.

A third benefit of exercise is its effectiveness. With the addition of T2 and ARED to our ISS exercise suite, crew member outcomes on standard medical tests have improved. Additionally exercise has other positive side effects such as stress relief, possible improvement of immune function, improved sleep, etc.

Exercise is not without its consequences. The major cons to performance of in-flight exercise are the time and equipment required. Currently crew are scheduled 2.5 hrs/day for exercise and there is considerable cost to develop, fly and maintain exercise hardware. While no major injuries have been reported on ISS, there is always some risk of injury with any form of exercise

There are several uncertainties going forward; these relate mostly to the development of small compact robust effective exercise devices for the next generation of space vehicles. It is becoming increasingly apparent that high intensity exercise is required for maintenance of fitness and functional capability and so future hardware will need to be developed, tested and implemented that allow for a wide variety of exercise, at high intensity while likely involving low mass, volume and power. There are many unanswered issues related to the minimum number and type of exercise devices required for exploration, optimizing exercise prescriptions for these devices, whether a treadmill is absolutely required, and even whether any single countermeasure can adequately protect muscle, bone, cardiovascular and sensorimotor function.